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ABSTRACT

The purpose of this study was to determine whether children as young as second-graders could encode categorically within an abstract evaluative dimension. The study uses mode of stimulus presentation (auditory or visual) as an independent variable. The subjects were 40 white middle class children from grades 2, 4, and 6, who were randomly assigned to one of four experimental conditions. A control group received four trials of words from the same subjective category. Interference between trials followed Wicken's release from proactive interference paradigm and consisted of a color naming distractor task. An experimental group received three trials of words from the same subjective category with a shift to another category on the fourth trial. The interference remained the same. Subjects were asked to recall the words after a 15 second interference duration. Some of the results indicated that the experimental groups at each grade level show an increase in recall from trial 3 to trial 4. Significant main effects were found for overall recall performance between grades and across trials. The mode of presentation did not appear to have a differential effect on the children's encoding at any grade level. (MKM)

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The Effects of Mode of Presentation on Encoding Processes in Children's Short-Term Memory[1]

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The study of encoding in memory research focuses on the input stage of information processing. Information input mechanisms are of import to the development of efficient memory functioning since information must be efficiently encoded in order to be further processed into a form permitting efficient retrieval. How a child encodes information will then effect subsequent processing and retrieval of that information. The study of encoding and factors affecting the development of the encoding process are thus of critical importance to the understanding of memory development.

A widely investigated encoding mechanism in short-term memory (STM) is the categorization of information. Underwood (1969) asserts that verbal information is encoded along a number of dimensions or categories in STM. Wickens (1970) hypothesizes that categorical encoding of these dimensions may be assessed experimentally through the release from proactive interference (PI) paradigm. In this procedure, triads of words from the same subjective category are presented briefly over a span of four or five trials.

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To prohibit rehearsal of the material, subjects are distracted for fifteen seconds immediately after each triad presentation. Following distraction, subjects are asked to recall the triad presentation. Categorical encoding is characterized by a decrement in recall performance over trials, hypothetically due to the increasing difficulty in distinguishing among the items from a common category in recall. The interference effect increases with successive trials resulting in a progressive decline in accuracy of recall. However, if stimuli from another category are presented on the fourth or fifth trial, performance on this trial is typically improved. The subject is "released" from the interference effect presumably because the newly encoded stimuli are more easily distinguishable as unique items and are therefore less subject to interference in retrieval. Wickens (1970) labels this phenomenon release from proactive interference (PI). The paradigm provides evidence for the categorical nature of the encoding process.

The release from PI paradigm is a potentially powerful tool in the investigation of the development of categorical encoding. Earlier studies have shown that young children can categorize words into essentially the same category structure imposed by adults (DiVesta, 1966; Annett, 1959). However, the spontaneous use of these categories by younger children is not a reliable phenomenon. Fourth graders did not spontaneously use the categories they formed in a sort task to structure their subsequent recall performance (Liberty and Ornstein, 1973). Several studies have used the release from PI technique to determine whether or not children use categories as encoding devices. Studies have shown that release from PI occurs with second and third graders using salient, age-appropriate dimensions such as taxonomic categories or number and letter triads (Cann, Liberty, Shafto and Ornstein 1972; Wagner, 1970).

Investigation of the encoding of more abstract categories with children has yielded equivocal results. Pender (1969) used words from the Evaluative dimension of the Semantic Differential (i.e. words categorized as having good or bad connotations) as stimuli in the release from PI paradigm with second- and sixth-graders and obtained a significant release effect. These results are in contrast to the findings of Cermak, Sagotsky and Moshier (1972) which suggested that second-graders could not use the Evaluative dimension as an encoding tool. Cermak et al. (1972) concluded that the development of the encoding process occurs between the second- and sixth-grades, with classification as shown by a build-up of PI, developing between the second and fourth grades and differential encoding, as shown by a release from PI, developing between the fourth and sixth grades. These results further complicate the question of whether young children can spontaneously use abstract categories as encoding devices. Further investigation is necessary to provide evidence for a better understanding of the level of cognitive maturity of second-graders and may reveal situational factors that account for the discrepancy of the Cermak et al. and Pender results.

There are several methodological differences between the Pender and Cermak et al. studies which may account for the equivocal results. The most obvious of these are differences in mode of stimulus presentation, the category salience of the particular stimuli used, number of words per trial, and rate of stimulus presentation. It seems that mode of stimulus presentation plays a critical role in accuracy of recall in adults (Chase and Calfee, 1969; Hopkins, Edwards and Gavelek, 1971). Perhaps this is the critical factor accounting for the discrepant results of Pender and Cermak et al. since Pender used an auditory presentation and Cermak used a visual presentation.

A systematic investigation of the effects of mode of stimulus presentation in developmental studies of the encoding process has not been carried out. An auditory presentation could facilitate the efficiency of the encoding process, thereby allowing the encoding of more abstract dimensions such as the Evaluative dimension. In an attempt to determine whether or not children as young as second-graders could encode categorically within an abstract dimension, the present study used mode of stimulus presentation (auditory or visual) as an additional independent variable. The Wicken's (1970) release from PI paradigm was used to test build-up and release from PI with second-, fourth-, and sixth-graders. Three factors were investigated: Ability to use the Evaluative dimension as an encoding tool, effects of auditory and visual presentations, and developmental differences as defined by grade level.

Method

Design

The design was comprised of three between-subjects factors: Grade level (second, fourth or sixth), Presentation modality (auditory or visual), and Experimental or control groups (shift or non-shift on the final trial). The number of correctly recalled words per trial served as a within-subjects repeated measure of performance. Subjects from each grade level were assigned to an auditory shift group, an auditory non-shift group, a visual shift group or a visual non-shift group. The non-shift groups received four trials of words from the same subjective category while the shift groups were shifted in category on the fourth and final trial. Order of category shifts was counterbalanced.

Subjects

Forty white, middle class children from each of three grade levels

(second, fourth and sixth) at St. Peter's Elementary School in Saratoga Springs, New York, were used in the experiment. Subjects in each grade level were randomly assigned to one of four experimental conditions. Each condition was balanced for sex. Pretesting of stimulus materials was performed on a similar group of second-graders at the Colonial Road School in Franklin Lakes, New Jersey.

Materials

Stimulus words were selected from the Heise (1965) and Osgood, Suci and Tannenbaum (1957) ratings of English words along the Semantic Differential. Twelve connotatively good words and twelve connotatively bad words were chosen. The words were pretested on a separate group of second-graders to ensure readability and salience of connotation. The words were grouped into two sets of triads and presentation of the trials was random. For the visual presentation, the words were lettered with 5/8" transfer letters and were presented individually through a 7" x 7/8" aperture of a 12" x 12" black screen. For the auditory presentation, the words were read to the subject. A ready signal consisted of either a star or the call "ready" and the recall signal was a printed question mark or the call "OK", depending on the experimental condition (auditory or visual) to which the subject was assigned. A color matrix of 84 circles (diameter = 2") of nine colors was used as a distractor task in which the subject named colors to the beat of a metronome.

Procedure

Subjects were tested individually with a modification of the Wickens (1970) paradigm. A color naming distractor task and the presentation of practice trials of unrelated material to familiarized the subject with the procedure were substituted. The female experimenter was seated across from

the subject and read the instructions for the task to the subject. Each subject received three practice trials. The ready signal was presented for two seconds, the stimulus triad for six seconds (two seconds per word), followed by a color naming task of fifteen seconds duration. The recall signal was then presented and the subject was given fifteen seconds to recall the words. A two-minute rest period was included between the conclusion of the practice trials and the onset of the test trials to allow for the dissipation of inhibiting effects that might carry over from the practice to the test trials. The inter-trial interval was six seconds, each subject receiving four test trials. Five orders of four triads were used under each condition. The experimental and control subjects were yoked in that they received the same order of numbered triads for the first three trials. On the fourth and final trial, the experimental subjects were shifted to the numerical equivalent of the non-shift triad presented to the control subjects.

Results

Figure 1 shows the mean correct recall on each trial for each of the subgroups for the second-, fourth-, and sixth-graders. Each shift group shows an increase in recall from trial 3 to trial 4 (the critical shift trial).

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Insert Figure 1 about here

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Conversely, each non-shift group shows a decrement in performance from trial 3 to trial 4 except for one group (fourth grade visual non-shift group) which shows no change in performance. Table 1 shows the mean recall on each

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Insert Table 1 about here

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trial for each group of subjects. The maximum possible score on each trial was three points. An overall analysis of variance (Winer, 1971) of the number of correct responses was performed on the between-subjects factors of condition (shift or non-shift), modality (visual or auditory) and grade level (second, fourth or sixth) and the within subjects factor of trials. Significant main effects were found for overall recall performance between grades (F (2,108) = 8.081, $p < .001$) and across trials (F (3, 324) = 13.637, $p < .001$). Significant interactive effects were found between the overall conditions of trials and shift/non-shift (F (3,324) = 7.335, $p < .001$). There was not a significant differential or interactive effect of the modality factor, indicating that mode of presentation did not have a differential effect on the children's encoding at any grade level.

Newman Keuls Multiple Range tests were performed on the significant main and interactive effects. Significant differences were found between the overall recall performance of the second- and fourth-graders ($p < .05$) and the second- and sixth-graders ($p < .01$). The difference in performance between the fourth- and sixth-graders was not significant. These findings indicate a developmental increase in capacity of recall. Significant differences were also found for all subjects on recall between trials 1 and 2 ($p < .01$), trials 1 and 3 ($p < .01$), and trials 1 and 4 ($p < .01$). No significant differences were found between any other combination of trials. However, differences between any other trial and trial 4 would be meaningless since trial 4 scores reflect both the shift and non-shift groups. No significant differences were found with the trials x shift/non-shift interaction between shift and non-shift groups on trial 1, trial 2, or trial 3. Thus, shift and non-shift groups did not differ in the initial build-up of PI. However, these groups did differ on the critical shift trial (trial 4) with recall of the shift groups significantly superior to that of the

non-shift groups ($p < .01$). Thus, a significant overall build-up and release from PI occurred for all experimental groups while only a build-up of PI resulted in the control group. These effects indicate successful encoding of the Evaluative stimuli at all three grade levels.

Discussion

The increase in the mean recall as a function of grade level parallels the results of the Cermak et al. (1972) study. These results imply that memory develops quantitatively. However, the quantitative increase in capacity may be due to the qualitative changes in the structures and strategies employed by the subject. The results of the present study indicate that a greater increase in the capacity of memory develops between the second- and fourth-grades than between the fourth- and sixth-grades within the Evaluative dimension.

More important, however, was the finding that children as young as seven years-old (i.e. second graders) cannot only categorize words along an abstract dimension but also that they can use this category spontaneously as an encoding device. Results of Cermak et al., 1972 suggested that while children are aware of these categories, they do not spontaneously employ them in the encoding process. The present data suggest that children can spontaneously encode within an abstract dimension as was suggested by the results of Pender (1969). There are a number of other factors which may account for the discrepancy between the results of the present study, Pender (1969) and Cermak et al. (1972).

First, the particular stimuli used in the studies differed. Although a seemingly trivial difference, the pretesting of material in the present study revealed that some of the stimuli used by Cermak et al. (1972) were considered by the second-graders to have a neutral connotation and thus,

would minimize any PI effects. Older children (i.e. sixth graders) might be more aware of the adult connotations which would allow them to correctly categorize the words, resulting in the build-up and release from PI found by Cermak et al. (1972). The stimulus materials for the present study were judged as categorically salient at the second-grade level based on the results of pretesting in which second-graders were asked to classify the words as "good", "bad", or "in-between". It seems that a higher degree of saliency within categories has a facilitative effect on categorical encoding. Consequently, younger children can spontaneously use a category as an encoding device, provided the category structure is sufficiently salient.

The timing of stimulus presentation is another important aspect of the procedure which may shed some light on the discrepancy of results among studies. Cermak et al. (1972) presented each trial (two words per trial) for two seconds before beginning the distractor task. However, Pender (1969) allowed for a five-second presentation of the triad followed by a five second rehearsal interval. The rehearsal interval was not used in the present study. Nevertheless, a longer presentation period was used (six seconds per triad) because pretesting indicated that younger children would need that amount of time to read three words. Both studies using the longer presentation rates obtained release from PI with second graders. The temporal aspect of stimulus presentation seems relevant to the phenomenon of release from PI. Perhaps the faster rates of presentation allow for a more stringent test of encoding in that they show the development of the efficiency in the encoding process. In the context of the previously discussed studies, it appears that older children (e.g. sixth graders) encode more efficiently since they were the only subjects who released from PI with the shorter presentation period.

Results of the present study indicate that each modality equally facilitates the encoding of the Evaluative dimension with children as young as seven years of age. These data do not necessarily imply that different modality presentations result in one and the same encoding process. The hypothesis of the two-store STM is not refuted since all groups were able to encode along the Evaluative dimension regardless of mode of presentation. Thus, there may be different encoding processes for auditory and visual information. However, it seems that both of these processes are functional in second-graders. If modalities are encoded differentially, it appears that this type of differential encoding initially develops in children before they reach the second- grade. It may be beneficial to investigate the differential encoding of modalities in pre-school or kindergarten children with the methodology used in the present study. The age levels would necessitate the use of non-verbal stimuli. If there exists an age level where a child could encode material presented in one modality and could not encode in another modality, it would follow that there are two processes of encoding or two stores in the STM--an auditory and visual store.

In summary, the results of the present study indicate that children as young as seven years of age can spontaneously use the abstract category of the Evaluative dimension of the Semantic Differential as an encoding device in both the auditory and visual mode. Although evidence has shown that this age group could use the Evaluative dimension in overt categorization, it seems that this categorization strategy is spontaneously used in the cognitive operations of these children.

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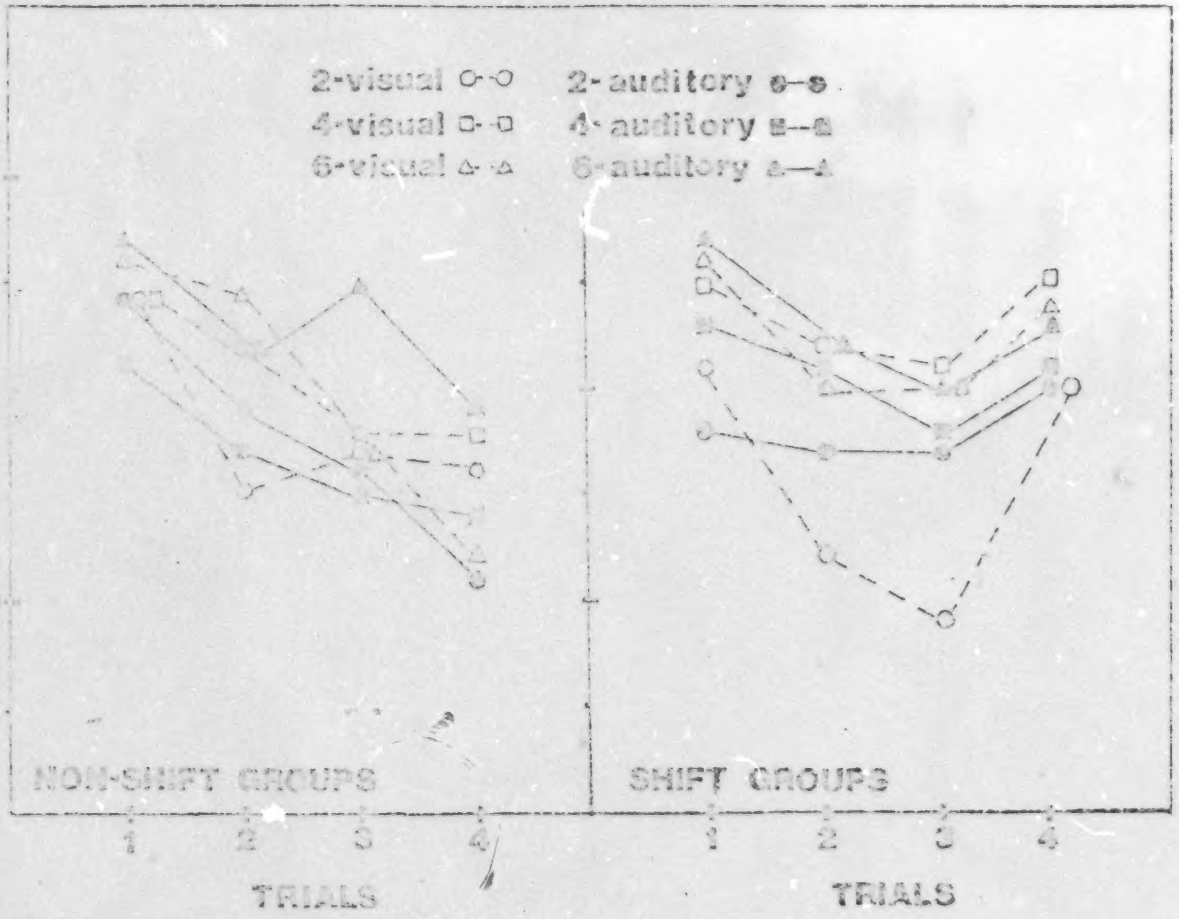
2-visual
4-visual
6-visual
2-auditory
4-auditory
6-auditory
3.0
1.0
NON-SHIFT GROUPS
SHIFT GROUPS
1
2
3
4
TRIALS
TRIALS

Table 1

Group Means of Correct Recall Over Trials

		TRIALS				
		1	2	3	4	Total
Grade 2	Auditory Shift	1.80	1.70	1.70	2.00	1.80
	Visual Shift	2.10	1.20	0.90	2.00	1.55
	Auditory Non-Shift	2.40	1.90	1.60	1.10	1.75
	Visual Non-Shift	2.40	1.50	1.70	1.60	1.80
Grade 4	Auditory Shift	2.30	2.10	1.80	2.10	2.08
	Visual Shift	2.50	2.20	2.10	2.50	2.32
	Auditory Non-Shift	2.10	1.70	1.50	1.40	1.68
	Visual Non-Shift	2.40	2.20	1.80	1.80	2.05
Grade 6	Auditory Shift	2.70	2.20	2.00	2.30	2.30
	Visual Shift	2.60	2.00	2.00	2.40	2.25
	Auditory Non-Shift	2.70	2.20	2.50	1.90	2.33
	Visual Non-Shift	2.60	2.40	1.70	1.20	1.98
Total		2.39	1.94	1.77	1.86	1.99